Second Generation CMORPH: A First Look at the Real-time Production

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Introduction

A test system has been developed at NOAA Climate Prediction Center (CPC) to produce a CMORPH, IR-based, and model integrated high-resolution precipitation estimation on a 0.05°lat/lon grid covering the entire globe from pole to pole (PTP). This new PTP "beta" version of CMORPH is currently running quasi-operationally (since 1 May 2017) at NOAA/NCEP/CPC in parallel to the operational CMORPH, however ATM not yet available for public use. The PTP global CMORPH system is built upon the Kalman Filter based CMORPH algorithm of Joyce and Xie (2011). First, retrievals of instantaneous precipitation rates from passive microwave (PMW) observations aboard low earth orbit (LEO) satellites are decoded and mapped onto a 0.05°lat/lon grid over the globe. The mapped PMW retrievals are then calibrated utilizing a PDF matching technique against a reference field, the TRMM/GPM TMI/GMI-based PMW retrievals over tropics and mid-latitudes. PMW retrievals over high latitudes and winter seasons consisting of cold surfaces however present a host of problems. Land and sea-ice retrieval methods rely on a weak signal of rainfall scattering on high-frequency channels that make use of empirical thresholding and regression-based techniques. Because of the increased surface signal interference, retrievals over complex surfaces including sea ice and snow covered land often result in either erroneously zero precipitation values or often extremely high precipitation anomalies. Thus for these regions and seasons, the Advanced Very High Resolution Radiometer (AVHRR) Global Area Coverage (GAC) 4km InFrared (IR) brightness temperatures (Tb) and associated cloud flag parameters present observations that can be used to indirectly estimate precipitation (LICOMB) from cloud top information.

Real time production model developed and running in parallel for the 2nd generation CMORPH

- Quasi operational production PTP CMORPH began 1 May 2017
- 0.05° lat/lon grid covering the globe from pole to pole
- Rainfall as well as snowfall
- 30-min interval updated at a reduced latency
- MWCOMB/CloudSat calibrated AVHRR derived precipitation for polar regions

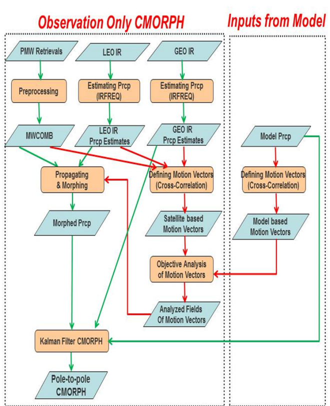
Technical issues remaining

•Refining technical components (IR-based precipitation estimates and cloud motion vectors)

•Optimizing the system for improved quantitative accuracy and computational efficiency

Overview of PTP CMORPH

- **INPUT Precipitation**
  - *PMW L2 from multiple satellites inter-calibrated to form MWCOMB*
  - *GEO/LEO-IR based precip estimates derived through calibration against MWCOMB*
  - *CFSR precip fields provide useful info over mid and hi-latitudes*
- **Precipitation motion vectors**
  - *First vectors computed separately from satellite and CFSR precip data*
  - *Satellite and CFSR based vectors blended through 2D-VAR*
- **Integration Framework**
  - *Kalman Filter based algorithm*



CloudSat calibrated AVHRR IRTB derived precipitation (LICOMB) over polar regions

- AVHRR cloud flag used to develop IRTB – vs- CloudSat CPR precipitation PDF matching models separate for cloudy and clear pixels
- S.H. winter precipitation estimation and gauge reports depict heavier amounts near Antarctic coast and peninsula regions much less over interior

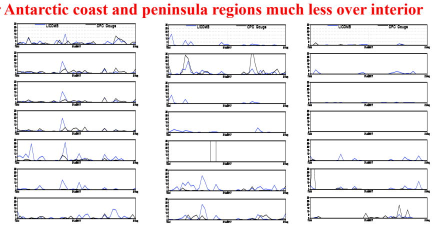


Figure 1. AVHRR LICOMB -vs- CPC Gauge [mm/dy] Antarctica: stations located on Antarctica peninsula (left) Antarctica coast (middle), Antarctica interior (right)

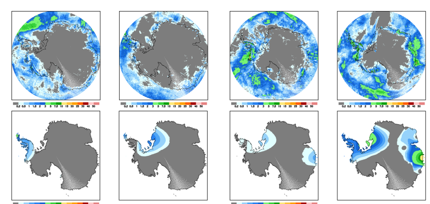


Figure 2. AVHRR LICOMB (top panels) CPC Gauge (bottom panels)[mm/dy] 25-29 Jul 2017 (Col.1) 30Jul - 3Aug 2017 (Col. 2) 4-8 Aug 2017 (Col.3) 9-13 Aug 2017 (Col.4)

PTP CMORPH + Operational CMORPH

- PTP MWCOMB utilizes finer and more accurate mapping
- Higher relative skill for both PTP MWCOMB and PTP CMORPH as depicted by both gauge and radar ground truth

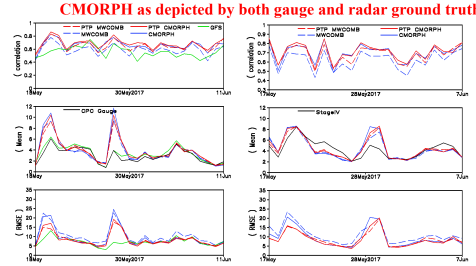


Figure 3. PTP & Operational MWCOMB, PTP & Operational CMORPH, & GFS precipitation relative to CPC Gauge 40N - 60N [left] (18 May - 11 June 2017); and against Stage IV precipitation (17 May - 7 June) [right]

Evaluating CMORPH at multiple near real time delay production latencies

- CMORPH correlation relative to MRMS increases significantly from 1 hour to 3 hour near real time latencies
- Bias reduces with increasing latency

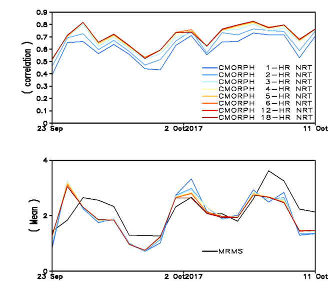


Figure 4. CMORPH at latencies of 1,2,3,4,5,6,12, and 18 hours -vs- MRMS precipitation correlation (top); mean (bottom)[mm/dy] for 23 September - 11 October 2017.

- CMORPH at multiple near real time production latencies and MRMS precipitation over CONUS

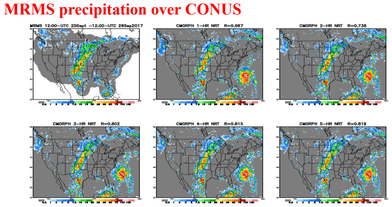


Figure 5. MRMS 24 hour accumulated precipitation (mm/day) 12 UTC 25 September - 12:00 UTC 26 September 2017 and CMORPH at latencies of 1,2,3,4, and 5 hours

CONCLUSIONS AND REFERENCES

- PTP CMORPH in beta mode production since 1 May 2017
- AVHRR cloud flag critical for PDF matching precipitation models
- Winter precipitation estimation and gauge reports generally agree over Antarctica regions
- More accurate PMW mapping in PTP MWCOMB
- Higher skill in both PTP MWCOMB and PTP CMORPH relative to operational CMORPH
- CMORPH correlation increases significantly from the 1 to 3 hour near real time latencies

•Joyce, R.J., Janowiak, J.E., Arkin, P.A., and P. Xie, 2004: CMORPH: A Method that Produces Global Precipitation Estimates from Passive Microwave and Infrared Data at High Spatial and Temporal Resolution. Journal of ydrometeorology Vol. 5, 487-503.

•Joyce, R.J., P Xie 2011, Kalman filter-based CMORPH Journal of Hydrometeorology 12 (6), 1547-1563.